

Amoozometer Studies in Kansas Soils

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Objectives

Overview of K_{sat} field studies in KS:

Background

Scope

Methodology

Results

Background

- 1) Saturated vs. Unsaturated Flow.**
- 2) Vertical vs. Multi-directional Flow.**

Saturated Flow in Soils

- Water moves at different rates depending upon moisture content.

Darcy's Law: $Q = -k A I$

*outflow = (hydr. cond.) x (Area) x
(gradient)*

- Maximum flow (saturated conditions)

Darcy's Law: $Q = K_{\text{sat}} A I$

$$K_{\text{sat}} = A I / Q$$

History

K_{sat} is satisfactory for engineering, hydrology (septic loading rates, etc.) and a convenient single condition to use as an index (to compare soils).

K_{unsat} is more desirable for irrigation, etc.

Historical Approach to Water Movement in Soils (in SSD)

Vertical movement of water through soil.

- Consistent with the dominant view of soils (*point-centric*).
- Knew about deep percolation, baseflow (*imply lateral flow*) but oversimplified.

Methods for vertical K_{sat}

Ex:

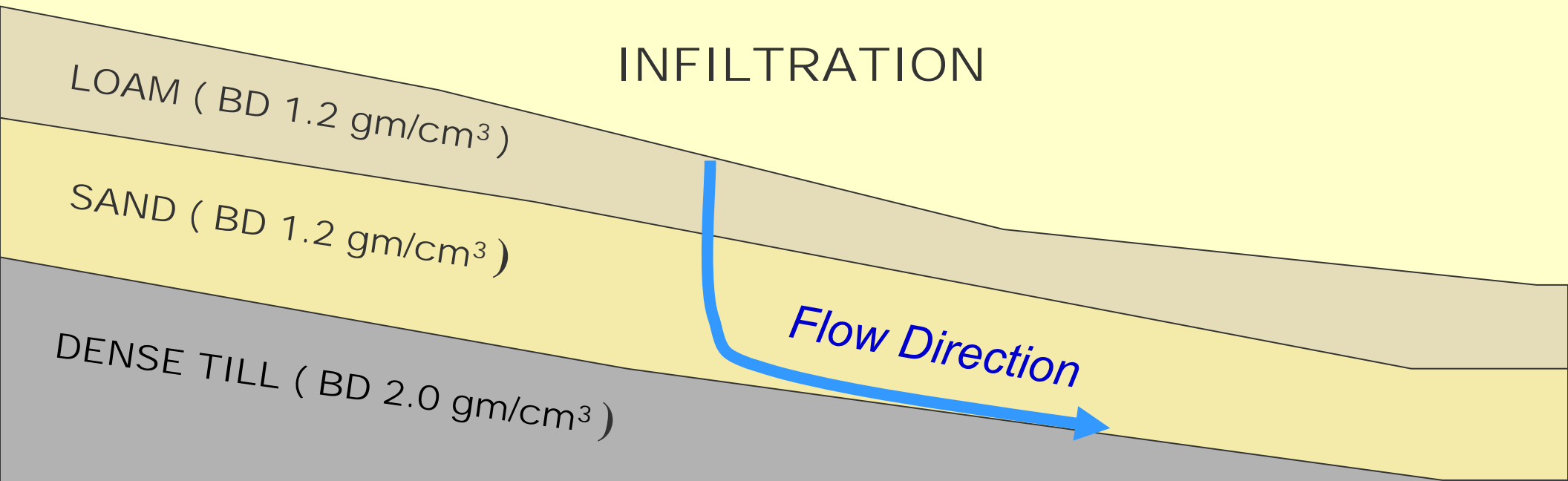
- undisturbed cores (*lab*)
- double ring infiltrometers (*field*)

Evolution

Multi-directional movement of water through soil.

Many uses: concern is how fast water moves away from application site (downward / lateral)

ANISOTROPY



Downward Flow Is Controlled By
The Most Restrictive Layer & Gravity

Anisotropy

fine sandy loam Alfisol

6 % slope

ANISOTROPY

Ex.: FOSSTON SOLID WASTE AREA, MN

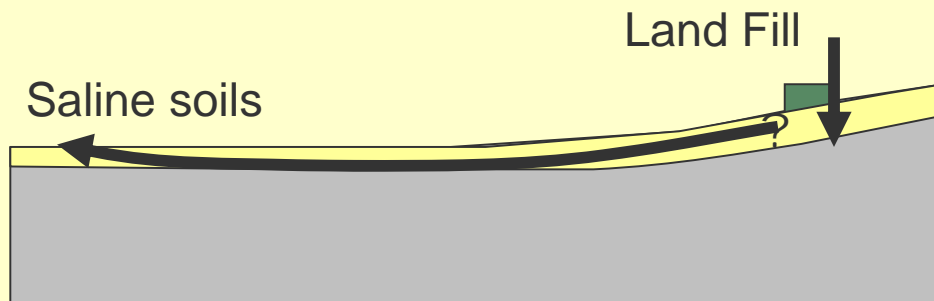
K_h = HORIZONTAL FLOW.

K_v = VERTICAL FLOW.

$$K_h = 1.2 \times 10^{-3}$$

$$K_v = 1.5 \times 10^{-7}$$

$$K_h/K_v = 8000$$



AQUIFER

VFSL

SCL

AQUITARD

CL

FSL

Evolution

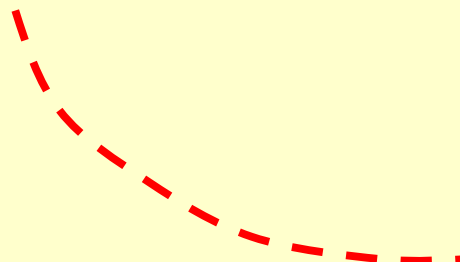
Multi-directional movement of water through soil.

Methods: field K_{sat}

- percolation test (*obsolete*)
- bore-hole permeameters *
- disc infiltrometers
- etc.

Bore-hole Permeameters:

Other Methods



Objective:

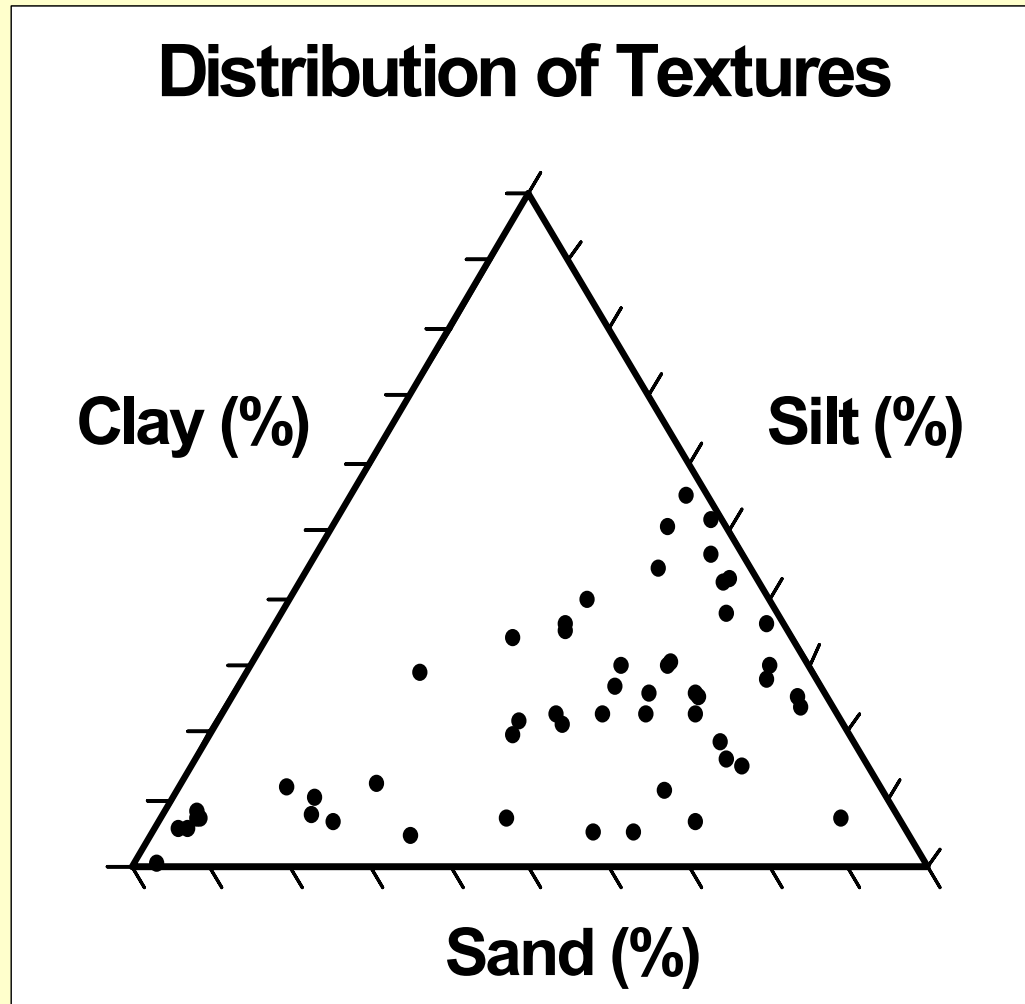
Acquire actual (measured) K_{sat} data on major layers of benchmark and other important soils over the mid-term.

(Currently $\approx 1/3$ of Benchmark soils mapped in KS)

Why? :

- **Augment Type Location information.**
- **Incorporates / addresses real world conditions.**
- **Provide hard data**
(not extrapolated estimates from cores, algorithms – none address mineralogy or structure).
- **Not programmatically burdensome.**
(limited annual impact; efficiency on site).

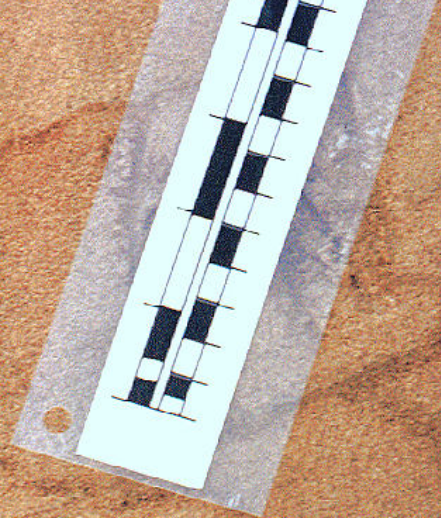
Results:



Seasonal Differences: Wet vs. Dry

Bavaria Soil (fine, smectitic, mesic, Leptic Natrustoll)			Saturated Hydraulic Conductivity Ksat (cm / hour)	
			Wet Season (5/6/98)	Dry Season (8/24/99)
			X C.V. (%) n = 3	X C.V. (%) n = 4
Soil Horizon	Depth (cm)	Field Texture		
Ap + An	20	silty clay loam	0.122 (102 %)	4.630 (105 %)
Btny	46	silty clay	0.075 (146 %)	0.262 (43 %)
Btn	77	silty clay loam	0.060 (135 %) n = 4	0.108 (87 %)

Lamellae in sand dune



Schoeneberger

Pratt Soil <i>(sandy, mixed, mesic Lamellic Haplustalfs)</i> (S05KS155-001)			Saturated Hydraulic Conductivity Ksat (cm / hour)
Soil Horizon	Depth (cm)	Texture	X C.V. (%) n = 5 (<i>unless otherwise noted</i>)
Ap	18	fine sand	13.218 (50 %)
Bt	36	loamy fine sand	5.554 (78 %)
E & Bt1	60	sand	9.553 (42 %)
E & Bt2	100	sand	16.640 (34 %)
C1	160	fine sand	18.953 (30 %)
			<i>n = 3</i>

Heavy textured soils.

<i>Pawnee</i> S2006KS131-001 Nemaha Co., KS			Saturated Hydraulic Conductivity K_{sat} (cm/hour)	
Soil Horizon	Depth (cm)	Lab Texture	X C.V. (%) n = 5	
Ap	18	silt loam	0.092 (46 %)	
Bt3	63	clay loam	0.021 (107 %)	
Btk	115	clay loam	0.008 (47 %)	
BC	150	clay loam	0.030 (82 %)	

